9:15

DOPPLER ASSESSMENT OF PULMONARY ARTERY FLOW PATTERNS AND VENTRICULAR FUNCTION AFTER FONTAN

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To assess the relationship between ventricular systolic and diastolic function and pulmonary artery flow patterns after the Fontan operation, we prospectively evaluated 15 post-op pts using 2-dimensional and Doppler echocardiography. Blood flow velocities in the PA were evaluated using pulsed Doppler echo. Ejection fraction (Ej fx) was measured from the 2-dimensional echo using Simpson's rule. Indexes of diastolic function were measured from the atrioventricular valve inflow Doppler and included peak E and peak A velocities, peak filling rate normalized for stroke volume, the fractions of filling in early and late diastole (E and A area fx), and the E/A velocity and area ratios. Compared to 15 age-matched controls, the 15 Fontan pts had decreased peak E velocity (.65±.20 vs .87±.10 m/s), decreased E/A velocity ratio (1.29±.23 vs 1.98 ±.46), decreased normalized peak filling rate (6.09±.90 vs 6.81±.83 sec^{-1}), decreased E area fx (.63±.09 vs .72±.07), increased A area fx (.37±.07 vs .24±.06), and decreased E/A area ratio (1.77±.45 vs 3.33±1.15)(p<.03). These diastolic filling abnormalities are consistent with impaired ventricular relaxation and decreased early diastolic transvalvular pressure gradient. PA Doppler recordings showed 2 distinct patterns of flow. Pattern I, observed in 9 pts, showed biphasic forward flow with peak velocities in mid-to-late systole and at atrial contraction. Pattern II, observed in 6 pts, showed decreased systolic forward flow, an early diastolic flow reversal, and delayed onset of diastolic forward flow. Compared to pattern I pts, pattern II pts had no significant differences in any of the Doppler indexes of diastolic function; however, pattern II pts had a significantly lower Ej fx (43±9 vs 57±5%, p<.01). Thus, many Fontan pts have impaired ventricular relaxation; but, in the presence of a normal Ej fx, biphasic forward PA flow is maintained (pattern I). With the development of decreased ejection fraction, it is likely that atrial systolic filling pressures are increased and the ventricular suction effect in early diastole is decreased. As a result, PA flow is diminished or absent in systole and early diastole (pattern II).

9:30

DOPPLER EVALUATION OF LEFT VENTRICULAR PEAK FILLING RATE IN NORMAL CHILDREN AND CHILDREN WITH LEFT VENTRICULAR OUTFLOW OBSTRUCTION

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To evaluate the early diastolic peak filling rate of the LV in normal children and children with LV outflow obstruction, we examined 3 groups of children with M-mode and Doppler echocardiography. The patient groups included 16 normal (NL) children aged 3-17 yrs, 7 children with valvular aortic stenosis (AS) aged 6-17 yrs, and 15 children with aortic coarctation (CoA) aged 2 mos-15 yrs. From the mitral valve inflow Doppler, the peak filling rate normalized to stroke volume (PFR/SV) was calculated as peak E velocity divided by the mitral valve velocity time integral. Peak instantaneous pressure gradient across the LV outflow obstruction was determined using Doppler echo and indexed LV mass was calculated from the M-mode echocardiogram using the American Society of Echocardiography convention. In the NL group, PFR/SV did not vary with heart rate, age, weight, or BSA. Compared to NLS, the AS patients had a decreased PFR/SV (4.93±0.79 vs. 6.75±1.03 sec^{-1}) and an increased LV mass (166±73 vs. 91±24 gm/m^2)(p<.01). Compared to NLS, the CoA patients had similar PFR/SV (6.62±0.95 vs. 6.75±1.03, p =.72) but had an increased LV mass (125 ±30 vs. 91±24 gm/m^2, p<.01). Compared to CoA patients, AS patients had lower PFR/SV (4.93±0.79 vs. 6.62±0.95 sec^{-1}), higher Doppler gradients (75±26 vs. 44±10 mmHg), greater LV mass (166±73 vs. 125±30 gm/m^2) and were older (11±4 vs. 6±5 yrs).

Conclusions:

Because it is independent of heart rate, age, weight, and BSA, the Doppler measurement of PFR normalized to stroke volume provides a particularly useful index of LV early diastolic filling rate in children. Compared to NL children, children with AS have a decreased PFR/SV that may be related to severe LV hypertrophy. Although CoA patients also had increased LV mass, their normal PFR/SV may be related to milder obstruction, shorter duration of exposure to high afterload, or better coronary artery perfusion than the AS patients.

9:45

A SIMPLIFIED METHOD TO ESTIMATE QP/QS BY DOPPLER IN CHILDREN WIH VENTRICULAR SEPTAL DEFECT

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Doppler derived QP/QS remains problematic in children with ventricular septal defects (VSD) due to errors in measuring the area component of flow. To eliminate this limitation we applied a simplified method to determine QP/QS by Doppler (DOP) which assumes that the ratio of mitral (MIT) to left ventricular outflow tract (Ao) cross sectional area (area) is constant. We first verified this assumption in children by measuring the MIT and Ao flow velocity integrals (FVI) by DOP in 63 normals from 1 wk-18 yrs of age. There was a close correlation between MIT and Ao FVI: Ao FVI = 1.47 x MIT FVI or Ao FVI/MIT FVI = 1.47 (r = .90).

In normals; Ao flow = MIT flow or
Ao FVI x area = MIT FVI x area
Solving for area component of flow,
MIT area/Ao area = Ao FVI/MIT FVI = 1.47

With VSD; QP/QS = MIT FVI x area/Ao FVI x area
= MIT FVI/Ao FVI x MIT area/Ao area
= MIT FVI/Ao FVI x 1.47

Thus only MIT and Ao FVI are required to estimate QP/QS. To test this simplified formula we estimated QP/QS by measuring MIT and Ao FVI in 12 patients with isolated VSD and compared the measurements to QP/QS derived by the Fick equation during catheterization (CATH). There was excellent correlation between DOP and CATH QP/QS (r = .93). This introduces a simplified and accurate method of determining QP/QS by doppler without measuring area component of flow in children with isolated VSD.

Thursday, March 7, 1991
8:30AM–10:00AM, Room 367, West Concourse
Cardiac Defibrillation I

8:30

SUBSTANTIAL REDUCTION IN DEFIBRILLATION THRESHOLDS IN DOGS USING A ONE CAPACITOR DUAL BIPHASIC WAVEFORM AND MULTIELECTRODE NONTHORACOTOMY LEAD CONFIGURATIONS

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The development of less invasive lead systems and lower defibrillation thresholds (DFTs) would improve implantable defibrillators. This study examined the efficacy of two biphasic shocks and of nonthoracotomy multielectrode configurations (CFGs) that were developed from cardiac mapping studies. In 8 anesthetized dogs, catheter electrodes were inserted into the RV apex (RV), superior vena cava (SVC), RV outflow tract (OT), and adjacent to the coronary sinus (CS). A cutaneous patch (P) electrode (41 cm^2) was placed over the left thorax. A small stainless steel patch electrode (4.3 cm^2) was attached to the LV apex (A). A CFG of RV catheter to P (RV→P) that used a +5.5/-5.5 ms biphasic shock was compared to three multielectrode CFGs: (1) RV→P, A→OT; (2) RV→P, A→CS; (3) SVC→RV, A→OT. These three CFGs used a +3.5/-2, +3.5/-2 ms dual biphasic waveform. The 1st biphasic (+3.5/-2) was applied to the 1st pair of electrodes and the 2nd biphasic to the remaining pair. After selecting the leading edge voltage of the 1st phase, the voltages of succeeding phases were adjusted to resemble the output of a single 150 μf capacitor defibrillator. DFTs were determined by using a modified Purdue technique 15 sec after electrically inducing fibrillation and were expressed as leading edge voltage and current, and total joules ± SD. Dual biphasic CFGs were compared to RV→P († = P<.01, * = P<.001).

	RV→P	RV→P, A→OT	RV→P, A→CS	SVC→RV, A→OT
Volts	377 ± 41	208 ± 18*	258 ± 26*	239 ± 32*
Joules	9.4 ± 2.4	2.7 ± 0.6*	4.4 ± 0.8*	3.9 ± 1.2*
Amps	5.2 ± 1.0	2.7 ± .5*	3.5 ± .5*	4.0 ± .9†

Even though all shocks had the same duration of 11 ms, 4 electrode CFGs that used dual biphasic waveforms produced significantly lower DFTs, possibly due to an increase in the voltage gradient in previously low gradient areas. These CFGs have the advantages that: (1) both shocks can be generated from one capacitor; and (2) a major thoracotomy is not required since the small apical electrode can be attached with a probe inserted below the xiphoid.